
SmagglIce User Guide

SmagglIce Version 1.2

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What is SmagglIce?

SmagglIce (Surface Modeling And Grid Generation for Iced Airfoils) is one of NASA's aircraft icing research codes developed at the Glenn Research Center. It is a software toolkit used in the process of aerodynamic performance prediction of iced airfoils. It includes tools which complement the 2D CFD process:

- measuring ice shapes for characterization
- surface preparation for gridding:
smoothing and re-discretization of geometry
- artificial ice creation

Future releases will also include support for all aspects of gridding:

- domain decomposition
- block boundary discretization
- block modification (e.g. divide block, merge blocks, etc...)
- grid generation and modification
- grid quality check
- CGNS output file
- linking with the flow solver (WIND)

Release Information

SmagglIce version 1.2 provides two types of software tools: interactive ice shape characterization and geometry preparation. The ice shape characterization tools provide users the means to measure the physical characteristics of ice such as icing limit locations, horn height and angle, and distance from the leading edge to any prominent ice location. The geometry preparation includes: ice shape control, artificial ice creation and rotation/translation of the geometry. The ice shape control features

provide the means to examine input geometry data, correct or modify any deficiencies of them, and perform a systematic smoothing of ice to a level that will make the CFD process manageable. The artificial ice creation tool provides users with geometries (such as triangle, rectangle, semi-circle, etc.) that can be attached to the current element (which should be a clean airfoil) to study the effects of various ice shape in the aerodynamic performance. The Move Element allows the user to rotate and/or translate airfoil components.

The code is still under development and is furnished as is, with no warranty of fitness for any particular use. You are not permitted to give the SmagIcice code to any other organizations and/or persons outside your company. We would be interested in knowing about any problems or errors that you experience with the codes, as well as any new features you would like to see included in future releases.

Contact Information

Questions and comments can be sent via e-mail to:
`smaggice@grc.nasa.gov`

Capabilities

Ice Shape Characterization

Interactive ice shape characterization is used in the process of characterizing ice shapes. Ice Shape Characterization involves making measurements of the data on the screen, recording those measurements in a table, and saving them to a file. Once the boundary data is read in, the user may make probing measurements. These include: point location (e.g., ice limits), distance between two points (e.g., ice horn height or width), “arc length” (i.e., the sum of the lengths of the line segments along a boundary between two points on that boundary), angle between two lines (e.g., horn angle), $(X-X_{le})/C$ (i.e., $(x-x_{LeadingEdge})/chordLength$), and ice area (the area between a segment of the ice and the corresponding segment of the clean airfoil). Location and distance may be normalized by the chord length of a clean airfoil. Ice area may be normalized by the area of the clean airfoil. The probe points can be selected by various methods: the closest point to any object, the closest point to the current object, the

closest point to the reference object, or an arbitrary point in space. Probing information may be saved to a text file and a corresponding graphics display can be saved to an image file.

Geometry Preparation

Ice Shape Control

Interactive ice shape control is used to prepare the surface for gridding. The types of functions that can be applied to surfaces are curve smoothing, discretization, and correction of obvious input errors such as a twisted ice surface. Any subcurve (or the entire curve) of an element can be selected for processing. Systematic smoothing of the iced boundaries in a controlled manner is accomplished using a control point formulation. With this feature, a user can smooth irregular ice surfaces to a level acceptable to his/her grid generation tools to gain insights to the effects of ice on aerodynamic performance. Users can control the level of smoothing by choosing the number of control points in constructing curves. Curve discretization provides a means of increasing/decreasing the number of points, distributing the points by curvature, and controlling the uniformity of their distribution. In addition, hyperbolic tangent stretching is provided. Direct reshaping of the curve is done by dragging control points associated with the curve. These control features of SmagglIce not only prepare the ice surface for the CFD flow simulation, but they also allow users to correct any deficiencies (e.g., twists, gaps, too many or too few points) in the input data.

Artificial Ice Creation

Adding parametric ice shapes to the surface of a clean airfoil is used to study the effects of surface roughness as well as various ice shapes on the airfoil aerodynamic performance. Once the clean airfoil data is read in, the user may interactively add different types of geometries to the clean airfoil. These geometric ice shapes include: forward-facing right triangle, backward-facing right triangle, generic triangle, rectangle, forward-facing quarter circle, backward-facing quarter circle, semi-circle and trapezoid. The user is able to set/modify parameters defining the artificial ice geometry.

Move Element

With this feature, the user can modify elements by rotation and/or translating the geometry. This may be useful to prepare for parametric studies

on multi-element configuration. For instance an aileron can be translated and rotated about a user-specified hinge point.

Implementation Issues

SmagglIce is written in FORTRAN and C. FORTRAN is used for the computational routines; C is used for the GUI, control, interaction, graphics, and memory management.

SmagglIce is intended to run on UNIX and PC platforms. It has been tested on SGI, Sun, HP, UNIX systems and PC platforms. The GUI was developed for X-windows, using Motif, Xt Intrinsics, and Xlib functions. This will aid in the portability of the user interface across multiple computer platforms running X. Whenever possible, the GUI uses higher level libraries (Motif widgets) rather than the functionally equivalent Xt or Xlib libraries, because the higher-level code hides many of the details. This makes the code less complex, so the application is more easily maintained.

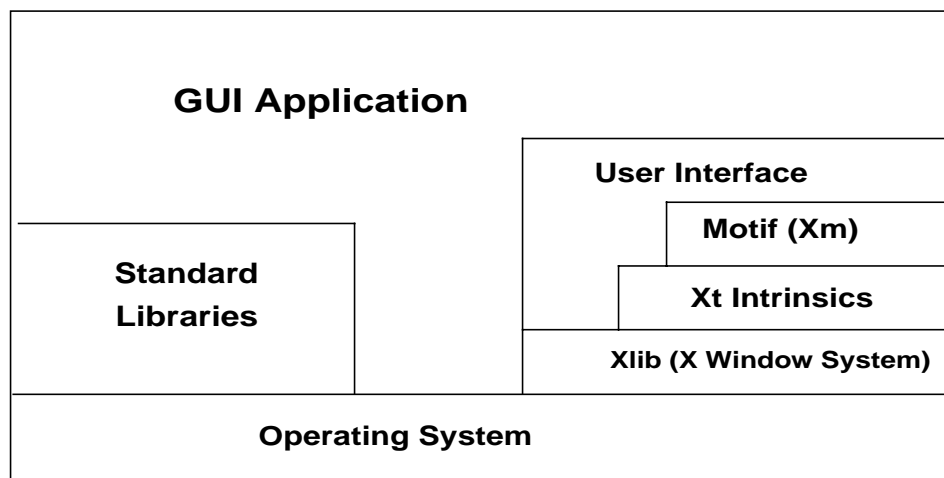


Figure 1. Diagram of the user interface library model.

The GUI provides a graphical mechanism for the user to interact with the data. Some of the SmagglIce functionalities which support the primary capabilities are: reading data, displaying 2D graphics objects, performing geometric transformations (such as translation, scaling, area zoom, zoom in, zoom out), and saving data and images to files.

OpenGL is used for the graphics drawing. It uses the GLX extensions to X to interface with the windowing system, but the Mesa library can be used if the client workstation does not have OpenGL or if the X server does not support the GLX extensions.

Dynamic memory management is used to allocate only as much memory as is necessary for data storage and access. This allows the program to process models whose size is limited only by the amount of memory on the host computer. It also allows multiple input files to be read in and processed during a single session. In addition, when data is no longer needed during a session, it can be cleared to allow for reading in new data. The data structures that make use of dynamic memory in Smagglce version 1.2 are illustrated here (Figure 2). As objects are read in, memory is allocated for them to store the object type as well as attributes describing the object. Space is also allocated for the data points defining the geometry, and a pointer stored with the object. When additional objects are read in, or as geometry is modified (e.g., points are added), memory is reallocated as needed. When objects are deleted, the memory is freed to make room for new objects.

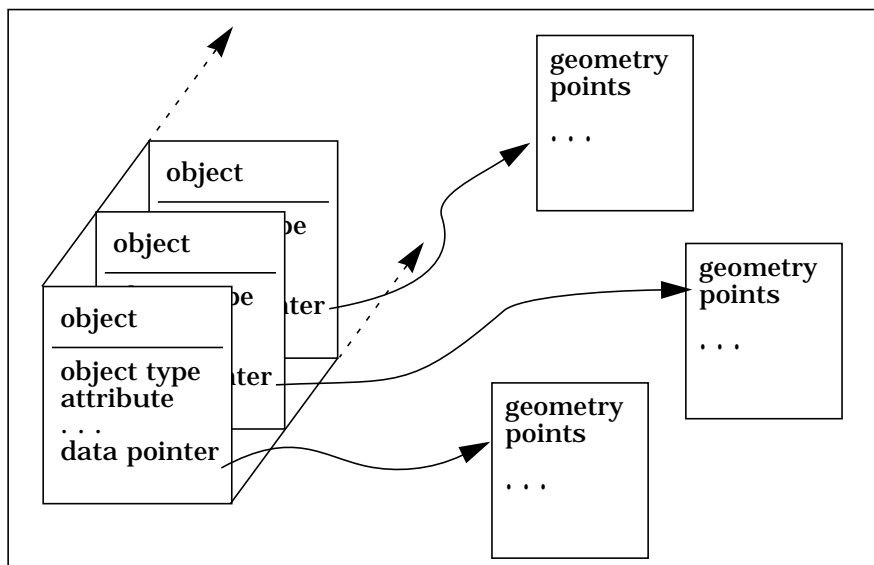


Figure 2. Data structures for multiple objects using dynamic memory.

Access and Installation

How to Get Smagglce

This computer program is available to any U.S. organization upon request. It is furnished on the condition that it will be used only within and for the U.S. organization which requests the software, and that it will not be transmitted to other organizations.

E-mail requests for software should be directed to:
Yung.K.Choo@grc.nasa.gov

System Requirements

Smagglce was designed and written to run on any Unix or PC platforms. It has been built for the following systems:

- SGI IRIX 6.5 (32 bit) using X and OpenGL
- SGI IRIX 6.5 (32 bit) using X without OpenGL
- SUN SunOS 5.8 using X and OpenGL
- SUN SunOS 5.8 using X without OpenGL
- Intel Linux 2.4.18 using X and OpenGL
- Intel Linux 2.4.18 using X without OpenGL
- Windows 2000 using X and OpenGL
- Windows 2000 using X without OpenGL

If you decide to run a version that uses OpenGL, you must have the OpenGL libraries installed on your system.

Currently, Smagglce is only distributed as a binary executable. If you need a version of Smagglce for a platform that is not included in the distribution, please contact the Smagglce team.

Distribution

SmagglIce is distributed on a CD-ROM. The CD contains:

1. README file with a description of the CD-ROM contents, and directions for installation and startup.
2. Executable SmagglIce version 1.2 for each supported system.
3. Sample input geometry files used in the tutorial.
4. This user manual in Postscript and PDF format.
5. On-line help files in HTML format.
6. Auxiliary files needed to set up and run SmagglIce.

You are not permitted to give the SmagglIce code to any other organizations and/or persons outside your company. We would be interested in knowing about any problems or errors that you experience with the codes, as well as any new features you would like to see included in the future.

If you need additional assistance, please contact the following developers:

Yung K. Choo at (216) 433-5868 or
Mary Vickerman at (216) 433-5067
e-mail: smaggice@grc.nasa.gov
fax: (216) 977-7469

UNIX Installation

1. Copy the contents of the CD-ROM to a local directory. For example:

```
> mkdir $HOME/smaggice1.2
> cp -r /CDROM/* $HOME/smaggice1.2
```

2. Change to that directory and edit the file `bin/runsmagg`. Detailed directions are in the file.

You will have to set at least two environmental variables in that file:

SMG_DIR - directory into which the SmagglIce distribution was copied
SMG_VENDOR - the architecture on which you are running

On some systems, you have the option of displaying the graphics using OpenGL or X only (without OpenGL). The default is to run the OpenGL version, if it is available. If you would rather run the X-only version, that option can be set here.

To display on-line help, you may need to set the variable `WEBBROWSER`.

PC Installation

Starting Smagglce on a Unix system

Before starting Smagglce, be sure you have modified the `runsmagg` script (which can be found in the `smaggicel.2/bin` directory), as described in step 2 of the Installation instructions.

To run Smagglce, invoke the `runsmagg` script in the `smaggice/bin` directory by specifying its full pathname. For example, if you have installed Smagglce in the directory `$HOME/smaggicel.2`, type:

```
> $HOME/smaggicel.2/bin/runsmagg
```

Alternatively, you may wish to add the `smaggicel.2/bin` directory to your path, then simply type:

```
> runsmagg
```

The Smagglce main window will be displayed.

Starting Smagglce on a PC system

Usage Overview

Smagglce deals with three main types of objects: elements, blocks, and grids. An element is either the entire or partial boundary geometry of a solid or a section of flow domain. For example, an element may be a clean or iced airfoil, or an isolated ice shape between upper and lower ice limits. Elements are typically processed in preparation for gridding to correct input errors, smooth the boundary, increase or decrease the number of points, and/or redistribute the existing points. Version 1.2 provides tools for working with elements only.

Since SmagglIce allows you to work with multiple objects, it must necessarily support the concept of a “current object”. Details of how to switch between objects and modify those objects are given in the next chapter.

Many SmagglIce functions are performed on subcurves of objects. Details of how to select and modify subcurves are also given in the next chapter.

As you begin using SmagglIce, you will see that the GUI is designed to provide “directed control” or “guided use”. This means that the user will be prevented, through the desensitization of widgets (menus, buttons, sliders, etc.), from selecting conflicting functions or functions that are invalid in certain situations.

Error checking is performed at all levels, starting at the GUI, whenever the user enters parameters. Any errors such as out-of-range data or invalid values are immediately reported so that the user can correct them.

SmagglIce main window

SmagglIce consists of a primary Main Window titled “SmagglIce - Surface Modeling and Grid Generation for Iced Airfoils” and sub-windows called:

- File Open
- Save As
- Screen Save
- Messages
- Ice Shape Characteristics
- Save Probe Information
- Add Artificial Ice
- Move Element
- Discretize Subcurve
- Change Free Form Subcurve
- Tanh Redistribution

The SmagglIce Main Window (Figure 3) is recognized by the following distinctive areas: **MenuBar** (*File, Edit, View, Element, Boundary, and Help* pulldown menus), **Information**, **Current Object Info**, **Graphics Window Mode**, **View Manipulation**, and **Graphics Drawing Area**. Sometimes items are “grayed-out” when certain selections have been made. This means that the item is temporarily unavailable. An example of this is the *Save As* or *Screen Save* selection. These are “grayed-out” when the user starts the

application, because no data has been read, so there is nothing that can be saved.

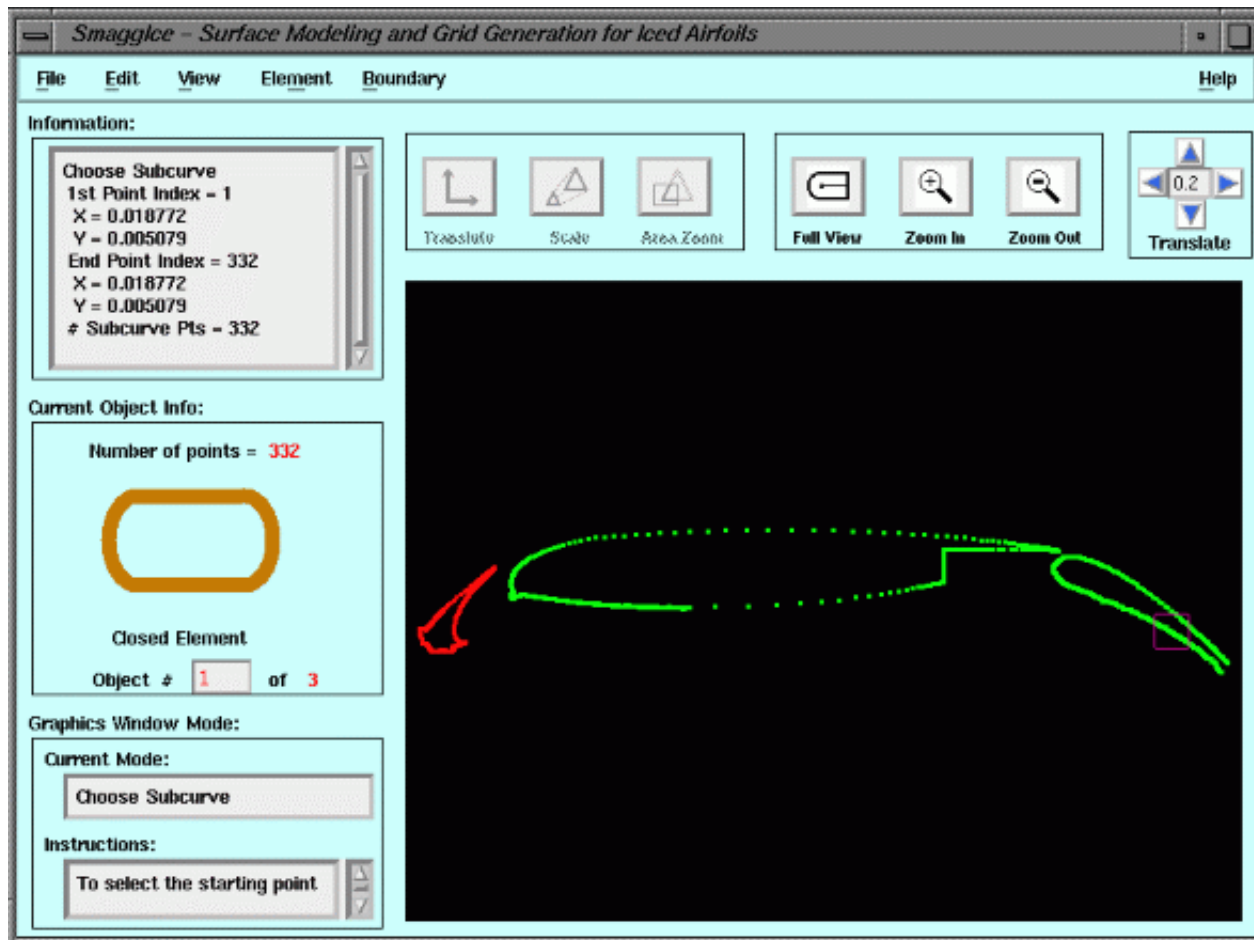


Figure 3. SmagglIce Main Window

MenuBar

There are six menu items in the MenuBar: *File*, *Edit*, *View*, *Element*, *Boundary*, and *Help*. Each of these will be described later in the manual section titled “MenuBar” (p. 19).

Information

While the user interacts with the graphics window, relevant information is displayed in the scrollable text area (Figure 4). For example, while probing, the coordinates of points are displayed here. As another example, when a subcurve is being selected, information on the subcurve endpoints is displayed here.

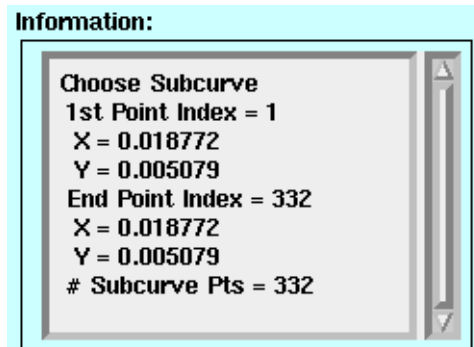


Figure 4. Information

Current Object Info

This area displays information about the current object such as: the type of object, its index number, and a graphics diagram specifying the object depending on its type (Figure 5). For example, when an element is selected, the number of points in the element is displayed, along with an indication of whether it is an open element or closed element. To switch to another object, making it the current object, you may type its index in the **Object #** text box and press <Enter>. Also, there is a non-editable textfield that contains the total number of objects that are currently available.

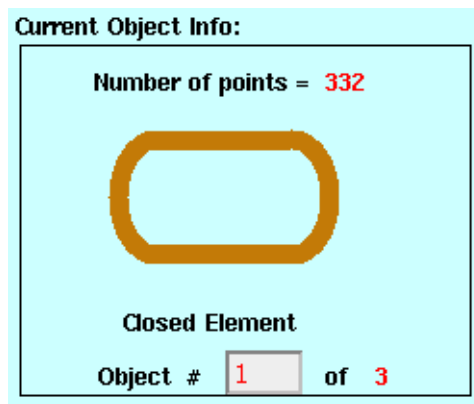


Figure 5. Current Object Info

Graphics Window Mode

The current mode is displayed here, along with instructions (Figure 6). Some of the graphics window modes are: Translate, Scale, Area Zoom, Choose Subcurve, and Display Point Coordinates. Depending on the mode, mouse movements and button clicks will have different effects. How to use the mouse in each mode is described in the **Instructions** scrollable text area.

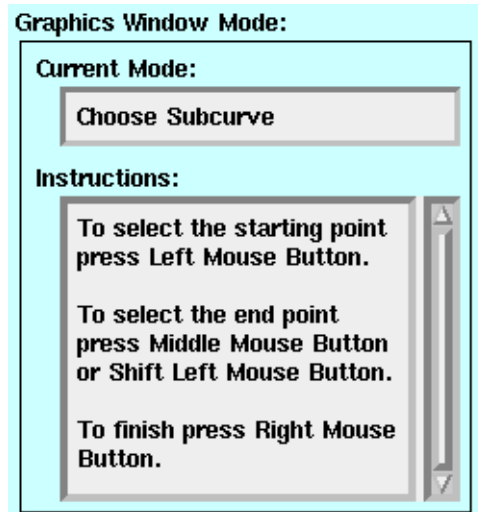


Figure 6. Graphics Window Mode

View Manipulation

These icon push buttons (Figure 7) modify your view of the geometry without changing the data itself. The first set of buttons, labeled **[Translate]**, **[Scale]**, and **[Area Zoom]**, set the mouse mode so that mouse button presses and movements modify the view continuously. **[Translate]** moves the geometry around on the screen without changing its size. **[Scale]** changes the apparent size of the geometry. **[Area Zoom]** allows you to draw a box around an area of interest and zoom into that area. Instructions for how to use the mouse in each instance is displayed in the *Instructions* scrollable text area in the Graphics Window Mode area. The second set of buttons, labeled **[Full View]**, **[Zoom In]**, and **[Zoom Out]**, change the view immediately when you press one of them. **[Full View]** modifies the view to include all geometry. **[Zoom In]** makes all geometry appear a little larger. **[Zoom Out]** makes all geometry appear a little smaller. The last set of arrow buttons labeled **Translate** also changes the view immediately. When an arrow button is pressed, it will move the

geometry the indicated fraction of the screen width in that direction. The fraction value may be changed by typing in another value in the textfield. The default fraction is 0.2.

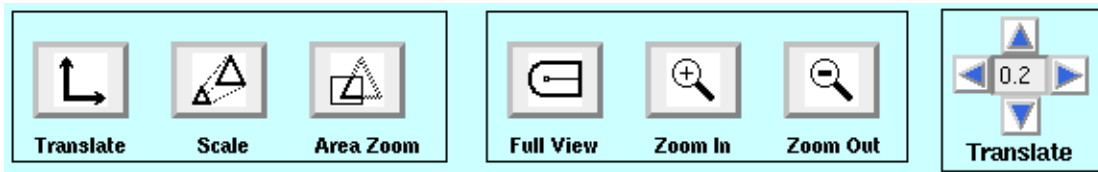


Figure 7. View Manipulation

Graphics Drawing Area

The Graphics area is where geometry is displayed and direct interactive manipulation of the geometry is performed. Depending on the current graphics mode, mouse button presses and movements will have different effects. Instructions for interactions in each mode is described in the **Instructions** scrollable text area in the **Graphics Window Mode** area.

MenuBar

This section gives information on the nine components of the MenuBar: *File*, *Edit*, *View*, *Element*, *Boundary*, and *Help*.

File

Currently, there are four actions that can be selected from the File Menu. They are *Open*, *Save As*, *Screen Save*, and *Exit* (Figure 8).

<u>F</u> ile	<u>E</u> dit	<u>V</u> iew
<u>O</u> pen ...		Ctrl+O
<u>S</u> ave As ...		Ctrl+S
<u>S</u> creen Save ...		
<u>E</u> xit ...		Ctrl+Q

Figure 8. File pulldown menu

Open - Displays the **File Open** window (Figure 15, p. 25). This window allows the user to select and read the geometry. More information is available under the section “File Open window” (p. 25).

Save As - Displays the **Save As** window (Figure 16, p. 29). This window allows the user to save the geometry of objects to a file. More information is available under the section “Save As window” (p. 29).

Screen Save - Displays the **Screen Save** window (Figure 17, p. 30). This window allows the user to save the Graphics Window as an image file. More information is available under the section “Screen Save window” (p. 30).

Exit - Presents a confirmation screen to either terminate the SmagglIce application or continue in the previous mode.

Edit

Currently, the only options available are *Clear All* and *Delete Subcurve* (Figure 9).

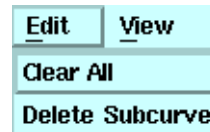


Figure 9. Edit pulldown menu

Clear All - Removes all the data objects from the Graphics Window and sets most of the attributes of SmagglIce back to their initial state, as when the program started.

Delete Subcurve - Presents a confirmation screen to either delete the currently selected subcurve or continue in the previous mode.

View

This menu allows the user to access the following: *Display Point Coordinates*, *Highlight Twisted*, *Highlight Reference Airfoil*, *Display Glyphs*, and *Messages* (Figure 10).

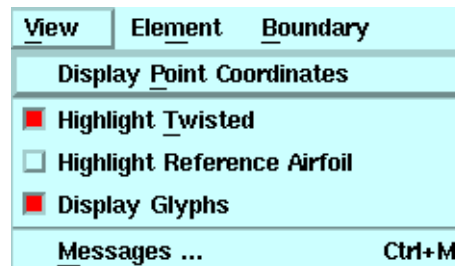


Figure 10. View pulldown menu

Display Point Coordinates - Once the user has selected this option, the graphics mode will be changed to “Display Point Coordinates”, so that each left mouse button press in the graphics window will select the closest boundary point in the current object. The point will be highlighted in the graphics display, and its index and (x,y) coordinates in input data units will be displayed in the Information section. Instructions for selecting the closest point with the mouse button will be displayed in the **Instruction** scrollable text area in the **Graphics Window Mode** section of the main screen.

Highlight twisted - Turns on or off highlighting twists (intersecting lines along the boundary) in elements. When an element is read in or after it is modified in the **Change Free Form Subcurve** window, a search is made for twists in that element. Up to 25 intersections may be found. If this toggle is on, the intersecting line segments will be highlighted, and a box will be drawn around the point of intersection. If the curve is later modified so as to remove the twists, the highlighted lines and box will be removed.

Highlight Reference Airfoil - Turns on or off highlighting of the reference airfoil. If a reference airfoil has been set and this toggle is on (i.e., the box is colored), the reference airfoil will be highlighted. Two additional reference points will also be displayed and selectable during probing operations: the leading edge point, and the center of the leading edge circle. If this toggle is off, the reference airfoil will be displayed in the same colors as all other objects, and the two additional reference points will not be displayed or selectable. To set the reference airfoil, make the reference airfoil the current object, and then select *Element->Set Reference Airfoil* from the main menu.

Display Glyphs - Sets the visibility of the probing glyphs “On” or “Off”. If this toggle is checked (i.e., the box is colored), the glyphs (lines and points representing measurements that are entered in the Probe Table) will be shown in the graphics display area, overlaid on the geometry. Turning off this toggle will turn off the display of these glyphs. However, the glyphs will continue to be defined (and displayable by setting the toggle on again), until *Edit->Clear All* is chosen from the main menu, or the **[Clear All]** button is pressed on the **Ice Shape Characteristics** window.

Messages - Displays the **Messages** window (Figure 11). This scrollable window keeps a running log of information, warning, and error messages.

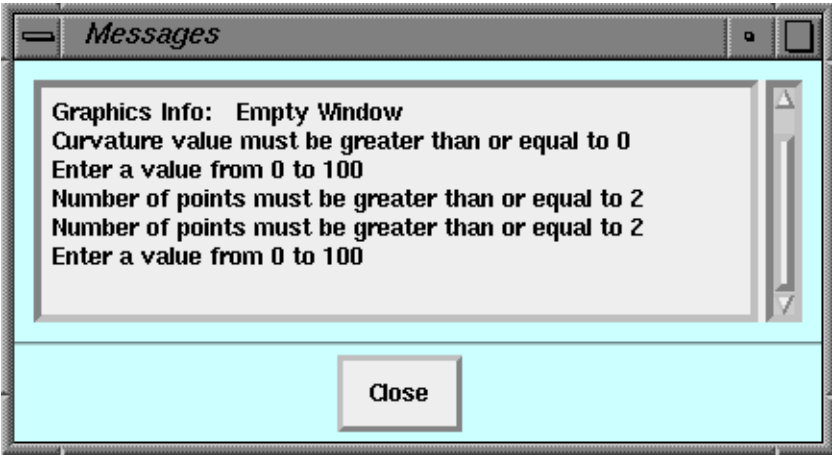


Figure 11. Messages

Element

This menu allows the user to access the following: *Ice Shape Characteristics*, *Set Reference Airfoil*, *Add Artificial Ice*, and *Move Element* (Figure 12).

Element	Boundary
Ice Shape Characteristics ...	
Set Reference Airfoil	
Add Artificial Ice ...	Ctrl+A
Move Element ...	Ctrl+V

Figure 12. Element pulldown menu

Ice Shape Characteristics - Displays the *Ice Shape Characteristics* window (Figure 18, p. 31). This window allows the user to probe geometry measurements (such as, location, length, arc length, angle, (X-Xle)/C, and ice area) for various point selection methods (such as: all objects, current object, reference airfoil, and arbitrary point). The user can enter the probe information in the Probe Table, and save the probe information to a file. More information is available under the section “Ice Shape Characteristics window” (p. 30).

Set Reference Airfoil - Identifies the current object as the reference airfoil. In order to request some probing measurements, such as: normalized length or (X-Xle)/C, a reference airfoil (usually one

without ice accretion) must be specified so that the chord length can be calculated and the leading edge can be identified. To set the reference airfoil, make the reference airfoil the current object, and then select *Element ->Set Reference Airfoil* from the main menu.

Add Artificial Ice - Displays the **Add Artificial Ice** window (Figure 19, p. 32). This window allows the user to add artificial ice shapes (such as: triangle, rectangle, semi-circle, and trapezoid) to the surface of a clean airfoil to study the effects of the various ice shapes on the aerodynamic performance. More information is available under the section “Add Artificial Ice” (p. 34).

Move Element - Displays the **Move Element** window (Figure 21, p 34). This window allows the user to translate the current element and/or rotate it about a hinge point. All the user input values are relative to the original data. More information is available under the section “Move Element” (p. 35).

Boundary

Currently, there are five actions that can be selected from the Boundary Menu. They are *Choose Subcurve*, *Discretize Subcurve*, *Change Free Form Subcurve*, *Tanh Redistribution*, and *Switch Object* (Figure 13).

Boundary	
Choose Subcurve	
Discretize Subcurve ...	Ctrl+D
Change Free Form Subcurve ...	Ctrl+F
Tanh Redistribution ...	Ctrl+T
Switch Object	Ctrl+W

Figure 13. Boundary pulldown menu

Choose Subcurve - Selects the subcurve for the current object. By default, when a boundary is read in, the subcurve is the entire boundary. Several functions in Smagglce (such as Discretize Subcurve, Change Free Form Subcurve, and Tanh Redistribution) are performed on “subcurves”. Instructions for setting the endpoints of the subcurve will be displayed in the **Instructions** scrollable text area in the **Graphics Window Mode** area of the main screen.

Discretize Subcurve - Displays the **Discretize Subcurve** window (Figure 22, p 36). This window allows the user to discretize the selected subcurve of the current object. The new discretized points are

displayed as blue crosses overlaid on the graphics display. More information is available under the section “Discretize Subcurve window” (p. 38).

Change Free Form Subcurve - Displays the **Change Free Form Subcurve** window (Figure 23, p. 39). This window allows the user to change the shape of the selected subcurve by using control points. More information is available under the section “Change Free Form Subcurve window” (p. 39).

Tanh Redistribution - Displays the **Tanh Redistribution** window (Figure 24, p. 41). This window allows the user to redistribute the points of the selected subcurve of the current object using a hyperbolic tangent redistribution method. The new point locations are displayed as blue crosses overlaid on the graphics display. More information is available under the section “Tanh Redistribution window” (p. 41).

Switch Object - Makes the next object in the list the current one. Smagglce has the concept of a “current object”, which is the object upon which functions are performed. This menu selection allows you to switch to the next object in the list of available objects. The hot key for this menu pick is <Ctrl>W. You may also switch to another object by typing the object number into the **Object #** text box in the **Current Object Info** area of the main screen and pressing <Enter>.

Help

This menu allows the user to access the following: *On Version*, *Online Help*, and *Hints* (Figure 14).

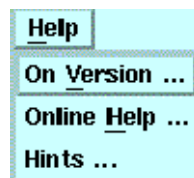


Figure 14. Help pulldown menu

On Version - Displays the following information: Smagglce Version, Release date, Copyright, and e-mail address of the contact person.

Online Help - All units of coordinates and distances are input data units read from the input files unless they are specified as chord units. All angles are measured in units of degrees. Displays online HTML documentation. Move information is available under the section “Online Help” (p. 40).

Hints - Lists the most frequently asked questions.

File Open window

The File Open Window allows the user to select and read geometry (Figure 15). The user selects from the **File Type** option menu the type of data to be read in. There are three file types available: *Element*, *IRT* and *Lewice*. An element is an object boundary. There are two different kinds of element boundaries. An open element has the first and last points at different x,y coordinates. A closed element has the first and last points at the same x,y coordinates.

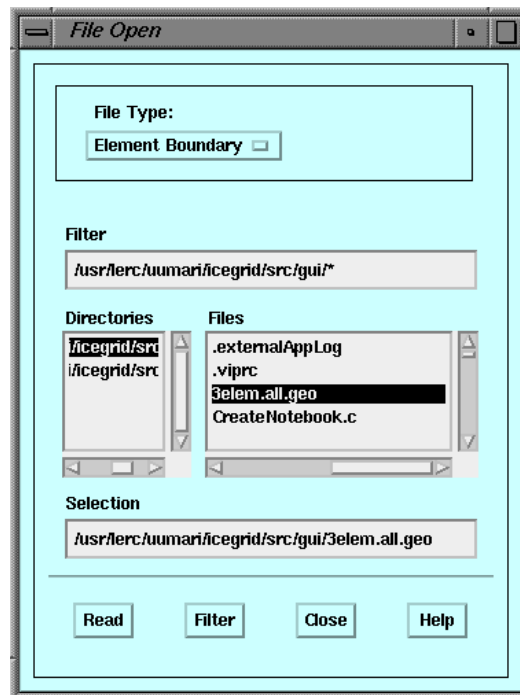


Figure 15. File Open Window

The following controls are used to specify the file to be read: **Filter**, **Directory**, **Files**, and **Selection**.

Filter - Filters or limits the filenames displayed in the **Files** list box. The directory initially displayed in this input box is the current directory (the one you were in when you started the application). You may

also type directly into the **Filter** text box the full path followed by a filename which may include an * to match any string of characters. Then press the **[Filter]** button at the bottom of the window.

Directories - Lists the directories matching the pattern in the **Filter** input box. If more names exist than can be displayed in the list box, the scrollbar will allow you to move through the list. You can navigate through directories by double-clicking on an entry in this scroll list.

Files - Lists the filenames matching the pattern in the **Filter** input box. If more names exist than can be displayed in the list box, the scrollbar will allow you to move through the list. Select a filename from this list by clicking on it or read the file by double-clicking its filename.

Selection - Displays the path and filename of the file you want to read. If the desired filename is not displayed, use **Filter**, **Directories**, and **Files** to select the desired filename or type the name of the path and file you want in this area. If the **Selection** input box already contains a name, you can edit the name as you would in any input box. Pressing <Enter> after typing the filename is equivalent to clicking the **[Read]** button or double-clicking a filename.

File Type

Three types of files may currently be read in, all of which define elements:

- Element (*Smagglce default*)
- IRT (*from the Glenn Icing Research Tunnel*)
- Lewice (*as output by Lewice software*)

All point data is read in and stored as double-precision.

Element file format

An element file contains data for one or more elements. The file consists of the following information, in the following order.

- Optional comments at the beginning of the file; # at the beginning of the line marks a comment line
- The number of elements defined in this file
- For each element:

- The number of points in the element
- Two columns, separated by spaces, containing the x,y coordinates of each point

Comments (indicated by a #) may be embedded anywhere in the file. Everything on the line after the # is ignored.

Element file example

```
# this file contains 2 elements
# an open square with 4 points,
# a closed hexagon with 7 points(only 6 of which are
distinct)
2      # number of elements
4      #number of points in 1st element
.1 .1 #start of points of the square (1st element)
.3 .1
.3 .3
.1 .3
7      #number of points in 2nd element
.5 .3 #start of point of the hexagon (2nd element)
.7 .3
.8 .5
.7 .7
.5 .7
.4 .5
.5 .3 #last point is the same as the first point; this is a closed
element
```

IRT file format

An IRT file contains only two elements: a clean airfoil and the ice on that airfoil. It consists of the following information, in the following order.

- Comments at the beginning of the file; a row of at least 10 equal signs (=====
=====) marks the end of the comment section
- Four columns of data, separated by space
 - 1st column contains the x-coordinates of the clean airfoil
 - 2nd column contains the y-coordinates of the clean airfoil
 - 3rd column contains the x-coordinates of the ice
 - 4th column contains the y-coordinates of the ice

The clean airfoil and the ice data do not have the same number of points, but if there are less points in the clean airfoil, blanks must be left in those columns.

IRT file example

Commercial Transport - Run 145m

Coordinates:

Clean	Airfoil	30"	Tracing
X/c	Y/c	X/c	Y/c
=====			
1.000	0.009	0.032	-0.018
0.782	-0.011	0.023	-0.022
0.539	-0.030	0.023	-0.017
0.295	-0.034	0.012	-0.019
0.066	-0.023	0.011	-0.013
0.000	0.000	0.005	-0.013
0.086	0.042	0.004	-0.009
0.287	0.056	-0.003	-0.011
0.555	0.050	-0.014	-0.015
0.797	0.029	-0.022	-0.018
1.000	0.010	-0.018	-0.009
		-0.015	-0.008
		-0.007	-0.002
		-0.007	0.008
		-0.018	0.013
		-0.020	0.022
		-0.008	0.018
		0.004	0.014
		0.008	0.020
		-0.001	0.030
		0.009	0.027
		0.023	0.025

Lewice file format

A Lewice file contains data for only one element. The file consists of the following information, in the following order.

- the number of points in the element
- two columns, separated by spaces, containing the x,y coordinates of each point

Lewice file example

```
4
.1 .1
.3 .1
.3 .3
.1 .3
```

Save As window

The **Save As** window allows saving elements to an Element file. The user selects from the **Save Object** option menu the type of data to be saved. There are two types of data that can be saved: *Current Object* and *All Elements*. The **Save Object** option determines what is written to the file:

Current Object - only the current object, regardless of its type, is written to the file

All Elements - all existing elements are written out to a single file

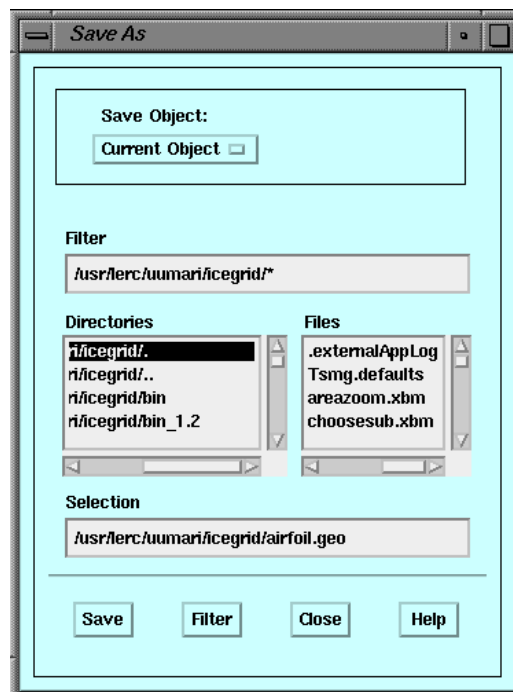


Figure 16. Save As Window

The following controls are used to specify a file where the data will be saved: **Filter**, **Directory**, **Files**, and **Selection**.

Selection - Displays the path and filename of the file you want to write to.

For the full description of each of these controls, see page 25 under the section “File Open window”.

Screen Save window

The **Screen Save** window allows the user to save the Graphics Window to a file. The **File Type** option menu determines the type of image file that will be saved: *GIF*, *TIFF*, or *PPM* (portable pixmap). The rest of the controls are used the same way as in the **File Open** and **Save As** windows.



Figure 17. Screen Save Window

Ice Shape Characteristics window

The **Ice Shape Characteristics** window allows the user to make measurements (such as location, length, arc length, angle, $(X-Xle)/C$, and ice area) using various point selection methods (such as all objects, current object, reference airfoil, and arbitrary point). The user can enter the probe information in the Probe Table, and this information can be saved to a file. This window consists of parameters, controls, and buttons.

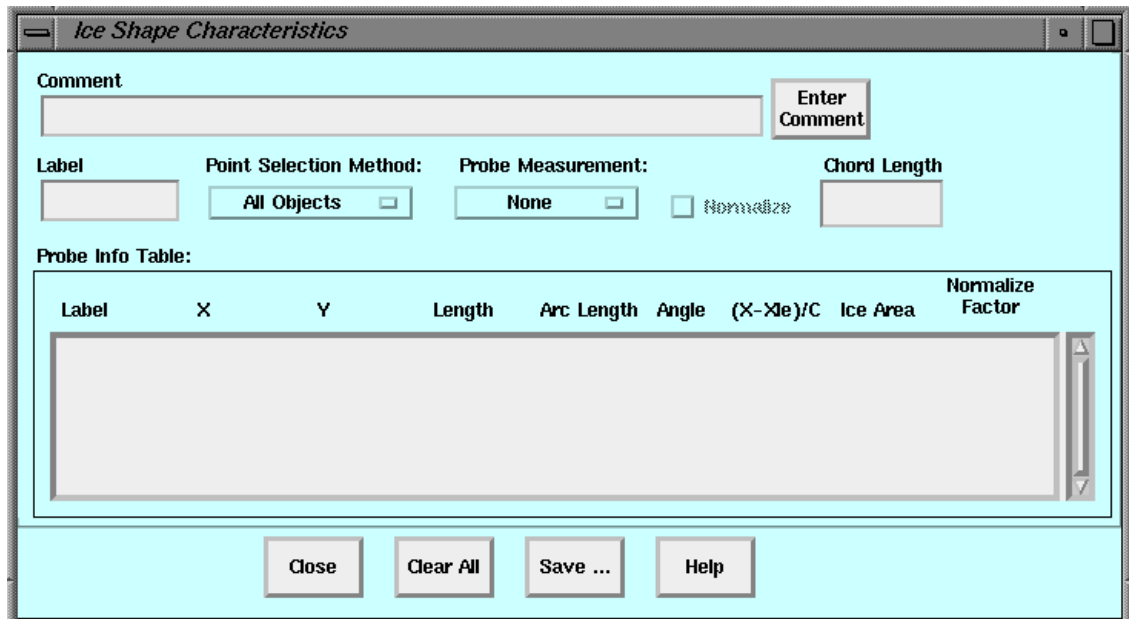


Figure 18. Ice Shape Characteristics Window

Parameters

Comment - Typing a string in this field has no effect until the Enter Comment button is pressed. At that time, the comment is entered on a separate line in the Probe Table.

Label - (up to 12 characters) Typing a string in this field just sets a value; no information is entered into the table until a measurement is made. At that time, this label, along with the measurement is entered into the table. This field may be blank.

Point Selection Method - selects the method used to find points when making measurements; one of: *All Objects*, *Current Object*, *Reference Airfoil*, or *Arbitrary Point*.

All Objects - the closest point will be chosen by searching through all the objects.

Current Objects - the closest point will be chosen from the currently-selected object only.

Reference Airfoil- the closest point on the reference airfoil will be chosen. In order to select this choice, a reference airfoil must

have previously been set (menu selection: *Element-> Set Reference Airfoil*). If the reference airfoil is highlighted (menu selection: *View-> Highlight Reference Airfoil*), two additional points will be available to be chosen: the leading edge of the airfoil, or the center of the leading edge circle.

Arbitrary Point - the point chosen does not have to be on an object.

You may change the point selection method at any time, even while in the middle of making measurements. So for example, when measuring length, one endpoint may be chosen using the Current Object method, and the second endpoint may be chosen using the Arbitrary Point method.

Probe Measurement - selects the probe type from the option menu; one of: *Location, Length, Arc Length, Angle, (X-Xle)/C, Ice Area* or *None*. This determines how the mouse will be used and what type of information will be entered into the Probe Table.

Location - a single point should be selected; its (x,y) coordinates can be entered in the Probe Table.

Length - two points on the boundary of a single object should be selected; the distance between the two points can be entered in the Probe Table.

Arc Length - two points on the boundary of a single object should be selected; the length of the line segments along the boundary between two points on the boundary can be entered in the Probe Table. The selection of the second point will be constrained to be on the same boundary as the first point. Also, since the points must be on a boundary, the *Arbitrary Point* selection method may not be used with this probe type.

Angle - two lines should be selected; the angle (in degrees) between the two lines can be entered in the Probe Table

(X-Xle)/C - a single point should be selected; this value can be entered in the Probe Table. Here X = the x-coordinate of the selected point, Xle = the x-coordinate of the leading edge of the reference airfoil, and C = the chord length of the reference airfoil

Ice Area - this measurement can only be made if there is a reference airfoil and at least one other element. Two points on the

boundary of a single element (which is not the reference airfoil) should be selected. Lines will be drawn to the closest point on the reference airfoil. The area bounded by those lines, the reference airfoil, and the other element will be computed. Normalizing the iced area is done by dividing by the area of the reference airfoil.

None - no probing type is active

Normalize - selects whether or not normalization will be performed when calculating location length, arc length, or the area. The location length and arc length are normalized by dividing by the chord length. Ice area is normalized by dividing by the area of the reference airfoil. This normalization factor (i.e., the chord length or reference airfoil area) will be entered into the Probe Table. Because the chord length or airfoil area are needed for normalized measurements, a reference airfoil must be set in order to be able to choose this option.

Chord Length - displays the chord length of the reference airfoil when a reference airfoil has been set. However, this field will only be used in calculations when the **Normalize** box is checked.

Controls

Probe data are calculated and entered into the table by using the mouse. The particular Probe Measurement selected determines how the mouse is used. But in general, the left and middle mouse buttons are used to select points or endpoints of lines, and the measurement information will be displayed temporarily in the **Information Area** of the Main Screen. Then when the right mouse button is pressed in the graphics window, the measurement information is entered into the Probe Table. The use of the mouse button clicks will be described in the **Instructions** scrollable text area in the **Graphics Window Mode** section of the Main Screen.

Buttons

[Enter Comment] - Enters the text specified in the comment field into the Probe Table as a separate line.

[Close] - Closes the window

[Clear All] - Clears all entries in the Probe Table.

[Save-] - Saves the data in the Probe Table to a file. A file selection window will open to allow you to specify the output file.

[Help] - Displays help information for the ***Ice Shape Characteristics*** window.

Add Artificial Ice

The Add Artificial Ice window (Figure 19) allows the user to add parametric ice shapes to the surface of the current element (which should be a clean airfoil) in order to study the effects that the various ice shapes have on the aerodynamic performance.

This window consists of

- **icons** representing the various ice shapes: forward-facing right triangle, backward-facing right triangle, generic triangle, rectangle, forward-facing quarter circle, backward-facing quarter circle, semi-circle, and trapezoid)
- **four areas** for entering user-specified parameters: Location, Replication, Size and Number of Points)
- **buttons** for completing actions

The user selects the parametric ice shape by pressing one of the eight icon push buttons. The background color of the icon that was selected will change from gray to blue to keep the user informed of their selected shape.

The user can modify the values that the system assigned by typing in the text fields and pressing <Enter> or toggling between the radio buttons. Figure 20 shows some of the settings that may be specified for different shapes.

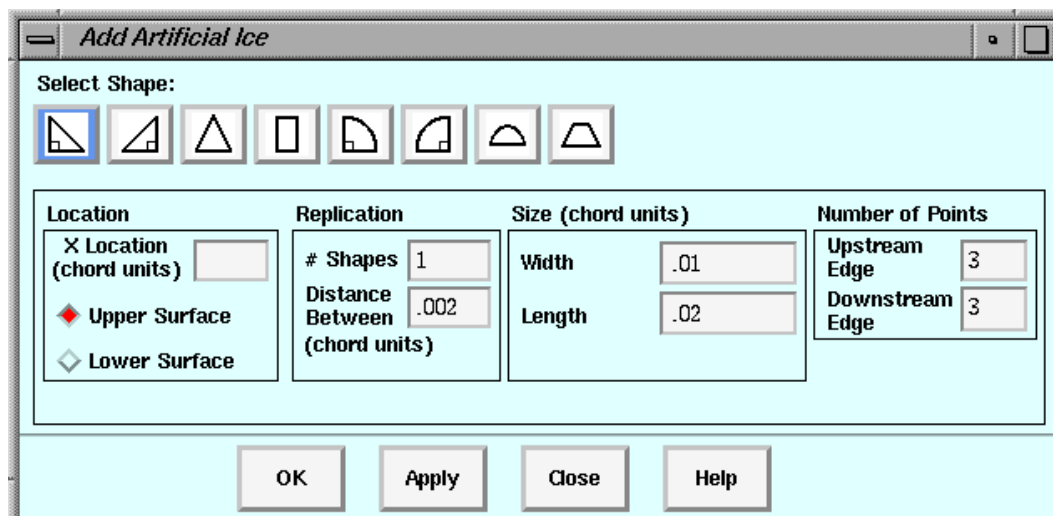


Figure 19. Add Artificial Ice

Select Shape

These icon push buttons (Figure19) select the parametric ice shape that will be added to the surface of the clean airfoil.

Location

X location - The ice shape will be placed on the surface of the airfoil at this X location (specified in chord units). Right triangles and quarter-circles will be placed with their right angle at this location. All other shapes will be placed with the center of their base at this location.

Surface selection - Select the surface, either “Upper surface” or “Lower surface”, on which the ice shape(s) will be placed.

Replication

of Shapes - If the user typed 1, a single shape will be added; a number greater than one will add a train of shapes. If the number of shapes is too high to fit on the surface, an information message will be displayed to the user.

Distance between - When the number of shapes is greater than 1, this sets the distance between (the space between) individual shapes in the train.

Size (chord units)

Depending on the shape that is being added, different parameters can be set. All sizes are in chord units, except angle. The angle is measured in degrees relative to the normal to the airfoil at the shape location. A positive angle will tilt the shape upstream, while a negative angle will tilt downstream.

triangle,
rectangle
width
length
angle

trapezoid
top width
bottom width
length
angle

semi-circle,
quarter-circle
radius

Number of Points

Depending on the shape that is being added, the number of points will be specified differently:

<u>triangle</u>	<u>rectangle,</u> <u>trapezoid</u>	<u>quarter-circle</u>	<u>semi-circle</u>
upstream edge downstream edge	x direction y direction	on arc y direction	on arc

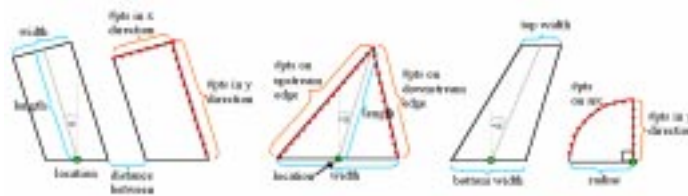


Figure 20. Some user specified parameters for the various ice shapes; left- train

Buttons:

[OK] - Permanently changes the geometry, by adding the ice shape geometry to the surface of the airfoil and closes the window.

[Apply] - Permanently changes the geometry, by adding the ice shape geometry to the surface of the airfoil.

[Close] - Closes the window without Applying changes.

[Help] - Displays help information for the **Add Artificial Ice** window.

Move Element

The Move Element window allows the user to translate the current element and rotate it around a specified hinge point. All the user input values are relative to the original data. For example, if a rotation of 10

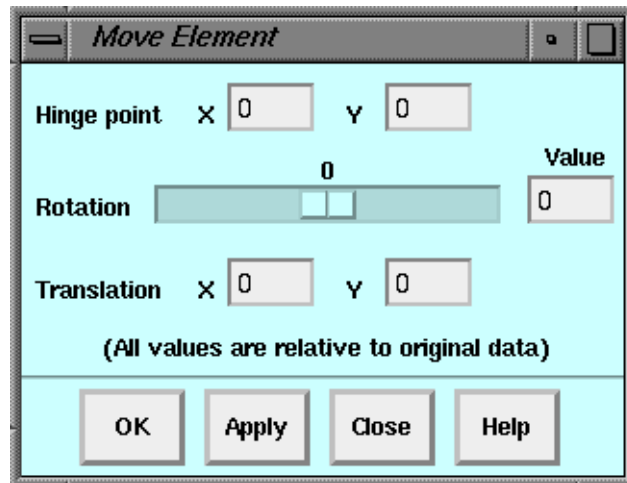


Figure 21. Move Element

degrees is requested and applied, then later a rotation of 15 degrees is requested, the element will be rotated 15 degrees from its original position (as read in), not by 25 degrees.

Parameters

Hinge Point

X,Y location - the point about which the object will be rotated.

Rotation - the amount of rotation to apply; a value in the range [-180.0,180.0]. A positive value will rotate counter-clockwise and a negative value will rotate clockwise. Change this parameter by sliding the horizontal scroll bar or by typing the value in the text box and pressing <Enter>.

Translation

X,Y location - the amount to translate the object.

Buttons:

[OK] - Permanently changes the geometry, by translating and/or rotating the current element according to the user-specified hinge point.

[Apply] - Permanently changes the geometry, by translating and/or rotating the current element according to the user-specified hinge point.

[Close] - Closes the window without Applying changes.

[Help] - Displays help information for the **Move Element** window.

Discretize Subcurve window

The **Discretize Subcurve** window allows the user to discretize the selected subcurve of the current object. The new discretized points are displayed as blue crosses overlaid on the graphics display. This window consists of parameters and buttons.

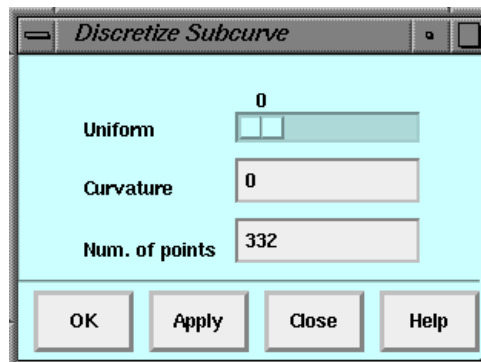


Figure 22. Discretize Subcurve Window

Parameters

Uniform - an integer value in the range [0,10]. A value of 0 makes no change to the original distribution, while a value of 10 distributes the points on the subcurve uniformly. Change this parameter by sliding the horizontal scroll bar.

Curvature - an integer value greater than or equal to zero. A greater number will cluster points more tightly in areas of high curvature. Change this parameter by typing an integer in the text box and pressing <Enter>.

Number of Points - the number of points in the discretized subcurve; an integer value greater than or equal to two. Change this parameter by typing the number of desired points in the text box and pressing <Enter>.

Buttons

[OK] - Applies changes and closes the window.

[Apply] - Permanently changes the curve, replacing the old points with the newly discretized points.

[Close] - Closes the window without Applying changes.

[Help] - Displays help information for the *Discretize Subcurve* window.

Change Free Form Subcurve window

The Change Free Form Subcurve window allows the user to change the shape of the selected subcurve by using control points. The new point locations are displayed as blue crosses overlaid on the graphics display. This window consists of parameters, controls and buttons.

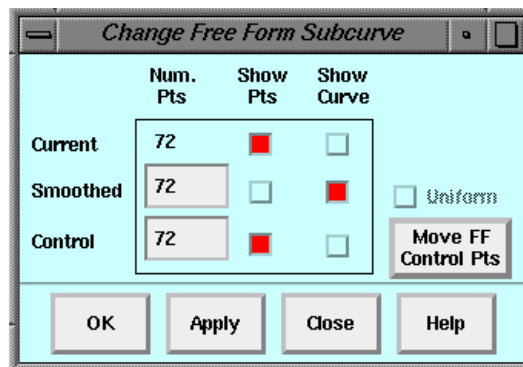


Figure 23. Change Free Form Subcurve Window

Parameters

Number of Smoothed Points - this textfield contains the number of smoothed points to be calculated for the new curve; an integer value greater than or equal to 3 must be used. Change this parameter by typing an integer in the text box and pressing <Enter>.

Number of Control Points - this textfield contains the number of control points to be used; an integer value greater than or equal to 3 must be used. Change this parameter by typing an integer in the text box and pressing <Enter>.

Controls

Show check boxes - allows you to select what will be shown in the graphics display while changing the free form subcurve. Points and/or curves for the current subcurve, the smoothed (modified) subcurve, and the control net can be displayed.

[Move FF Control Pts] - Sets the graphics mode to Move FF Control Points. While in this mode, you may move the control points, thereby changing the shape of the subcurve. Instructions for moving the control points will be displayed in the **Instructions** scrollable text area in the **Graphics Window Mode** area of the main screen.

Uniform - this option is currently not available.

Buttons

[OK] - Applies changes and closes the window.

[Apply] - Permanently changes the curve, replacing the old points with the new points.

[Close] - Closes the window without Applying changes.

[Help] - Displays help information for the ***Change Free Form Subcurve*** window.

Tanh Redistribution window

This window allows the user to redistribute the points of the selected subcurve of the current object using a hyperbolic tangent redistribution method. The new point locations are displayed as blue crosses overlaid on the graphics display. This window consists of parameters and buttons.

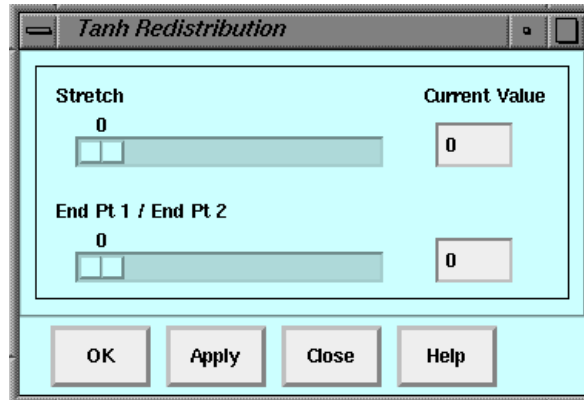


Figure 24. Tanh Redistribution Window

Parameters

Stretch - the amount of stretch to apply; an integer value in the range [0,100]. Change this parameter by sliding the horizontal scroll bar or by typing an integer in the text box and pressing <Enter>.

EndPt1/EndPt2 - indicates the endpoint toward which subcurve points will be clustered; an integer value in the range [0,100]. A value of 50 will stretch points equally towards both endpoints. Change this parameter by sliding the horizontal scroll bar or by typing an integer in the text box and pressing <Enter>.

Buttons

[OK] - Applies changes and closes the window.

[Apply] - Permanently changes the curve, replacing the old points with the redistributed points.

[Close] - Closes the window without Applying changes.

[Help] - Displays help information for the *Tanh Redistribution* window.

Online Help - UNIX

The SmagglIce help files are stored in HTML format. On UNIX systems, the on-line help is displayed using Netscape. If you have trouble displaying on-line help from SmagglIce, make sure Netscape is available on your workstation, and check to make sure the environmental variable `WEBBROWSER` was set correctly in the file `bin/runsmagg` in the `smaggice` directory. You may also view the help files independently of SmagglIce by pointing your browser to the file `help/index.html` in the `smaggice` directory.

Online Help - PC

The SmagglIce help files are stored in HTML format. On Windows systems, the on-line help is displayed using Internet Explorer. If you have trouble displaying on-line help from SmagglIce, make sure Internet Explorer is available on your PC, and check to make sure the environmental variable `WEBBROWSER` was set correctly in the file `bin/runsmagg` in the `smaggice` directory. You may also view the help files independently of SmagglIce by pointing your browser to the file `help/index.html` in the `smaggice` directory.

This chapter will step you through the some general tasks in Smagglce, and then present several scenarios: view modification, boundary modification, and probing.

Note: If you have installed Smagglce in a directory other than `$HOME/smaggice1.2`, modify all the pathnames in the tutorial accordingly.

General tasks

This section will walk you through some general tasks that you will need to be able to do whenever you use Smagglce.

Start Smagglce

Start up Smagglce by executing the `runsmagg` script, which can be found under the `bin` subdirectory of `smaggice`. Enter it at the shell prompt, making sure to specify the full path name. For example:

```
$HOME/smaggice1.2/bin/runsmagg
```

Read geometry

You will read in a three-element airfoil. Select from the main menu:
File->Open

In the *File Open* window,

- Select *Element Boundary* as the **File Type**.
- Read the file: `3elem.all.elc`
from the directory `$HOME/smaggice1.2/geometry`.
- Close the window.

Select current object

SmagglIce performs operations on the current object. You may select the current object using one of these methods:

- Select from the main menu: *Boundary->Switch Object*. Do this several times to switch between the three objects.
- Use the hot key <Ctrl>W. You may do this several times in succession to cycle among objects.
- Type an object number directly into the **Object #** text box in the **Current Object Info** area of the main screen. Try entering 2 to switch to object number 2.

Notice that the selected object is displayed in red, and the non-selected objects are displayed in green. Also notice the information that is displayed in the **Current Object Info** area on the left portion of the main screen.

Get on-line help

On-line help is available and displayed through your web browser.

- To request general help from the main window, select from the main menu, *Help->Online Help...*
- As you start using other SmagglIce windows, you will see that specific help may be accessed by pressing the **[Help]** button at the bottom of each of those windows.

Clear all

At times you will want to clear all graphics and data, and return SmagglIce to its initial state.

- From the main menu, select: *Edit->Clear All*.

Exit

To exit SmagglIce,

- From the main menu, select: *File->Exit...*

You will be asked to verify your choice.

- Press **[Yes]** to exit.

Scenario 1 - View modification (geometry transformation)

This section will explain how to perform geometry transformations to change the view you have of the geometry. You will be using the seven widgets across the top of the screen to do this.

Startup

- Start SmagglIce (or select *Edit->Clear All*, if already running a session).
- Read the formatted element file: `3elem.all.elt` from the directory `$HOME/smaggice1.2/geometry`.

Graphics Mode transformations

The three buttons on the top left of the graphics window (**[Translate]**, **[Scale]**, and **[Area Zoom]**) set the Graphics Window mode so that mouse movements in the graphics window will change the view. When you select any one of these, you will notice that the mouse cursor changes to indicate that you are in a special view manipulation mode.

- Press the **[Translate]** button (notice that it turns blue, to indicate that the Translate mode is active), then follow the instructions in the lower left corner of the main screen to move the geometry around.
- Press the **[Scale]** button. This will switch you to Scale mode and allow you to enlarge or reduce the image.
- Press **[Area Zoom]**. This allows you to draw a box around an area that will be enlarged to fill the screen.
- To exit any of these modes, click on the button again. The button will turn gray to indicate that the mode is not active, and the mouse cursor will return to its previous shape.

Immediate transformations

The four sets of buttons on the top right of the graphics window (**[Full View]**, **[Zoom In]**, **[Zoom Out]**, and **Translate arrows**) immediately change your view of the geometry.

- Press **[Full View]** to reset the view to include all of the geometry.
- Press **[Zoom In]** or **[Zoom Out]** to scale the geometry up or down incrementally.
- Press one of the **Translate arrows** to move the geometry up, down, left, or right by the specified window percentage. You may also change the percentage by typing a new value in the center box of this widget.

Scenario 2 - Boundary modification

This section will show you how to select and modify subcurves.

Startup

- Start SmagglIce (or select *Edit->Clear All*, if already running a session).
- Read the element file: `clean+2ice.elc` from the directory `$HOME/smaggice1.2/geometry`.
- Notice that there are three objects: the full clean airfoil (a closed element) and two ice shapes (open elements). Make sure that object 1 is selected.



Figure 25. Geometry file: `clean+2ice.geo`; object 1 selected.

Select subcurve

Initially, the selected subcurve for an element is the entire curve. You will usually want to select only part of the curve to work with.

- From the main menu, select: *Boundary->Choose Subcurve*.
- Your cursor will change to indicate that you are in a special mode for selecting points. The instructions in the lower left corner of the screen will tell you how to select the endpoints of the subcurve. As you select the endpoints of the subcurve, notice how the information in the upper left corner of the screen changes. Also note that the points on the subcurve are displayed in red, while the points not on the subcurve are displayed in orange.
- Select the upper surface of the airfoil as the current subcurve. This will be between point indices 1 and 83. You may find it easier to select specific points by using the mouse to click near the point, then using the arrow keys to set the exact point. The left and right arrow keys can be used to change the index of the most recently selected subcurve endpoint.
- To exit the Choose Subcurve mode, press the right mouse button.

Hyperbolic tangent redistribution

This allows you to redistribute the points in the selected subcurve. This tool will let you concentrate the distribution of points near the leading and/or trailing edge(s).

- From the main menu, select: *Boundary->Tanh Redistribution...*
- Notice that two sets of points are displayed: the current points as red dots and the modified points as blue crosses.
- You may change the amount of stretch and how the stretching is distributed between the two endpoints by using the sliders in this window. You can also change a value by typing a number in the appropriate text entry area and pressing <Enter>. Set the **Stretch** value to 100 and the **EndPt1/EndPt2** value to 50.
- If you would like to replace the current points with the modified points, press [**Apply**]. To close the window without making the changes permanent, press [**Close**]. Pressing [**OK**] will apply the changes and close the window all at once.

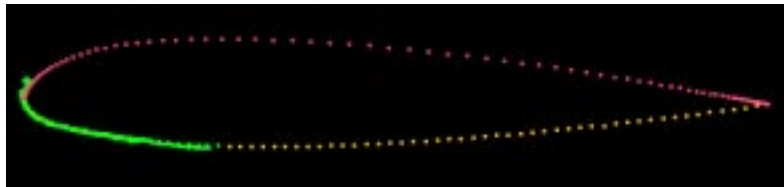


Figure 26. Redistributed points on upper surface of airfoil.

Discretize subcurve

This allows you to change the number of points in the subcurve and how they are distributed.

- Switch to object 2, and zoom in on the area at the leading edge of the airfoil (Figure 27). Select indices 1 and 56 as the endpoints of the subcurve by using the *Boundary->Choose Subcurve* menu selection.
- From the main menu, select: *Boundary->Discretize Subcurve...* If this menu selection is grayed out, it may be that you are still in the Choose Subcurve mode. (Follow the instructions in the lower left corner of the main screen, and click the right mouse button to exit that mode.)
- Again, the current points are displayed as red dots while the modified points are displayed as blue crosses.
- To change the **Uniform** parameter, drag the slider. To evenly distribute the points, set this to the maximum value of 10.
- Change the number of points in the subcurve to 100, by typing that value in the text field and pressing <Enter>.

- Press **[Apply]** to make the changes permanent.
- You may want to concentrate the distribution of points near areas of high curvature. Set the **Uniform** parameter back to 0, then type a value of 2 or 3 in the **Curvature** text field and press <Enter>.
- Make the changes permanent, or discard the changes the same way you did in the *Tanh Redistribution* window.

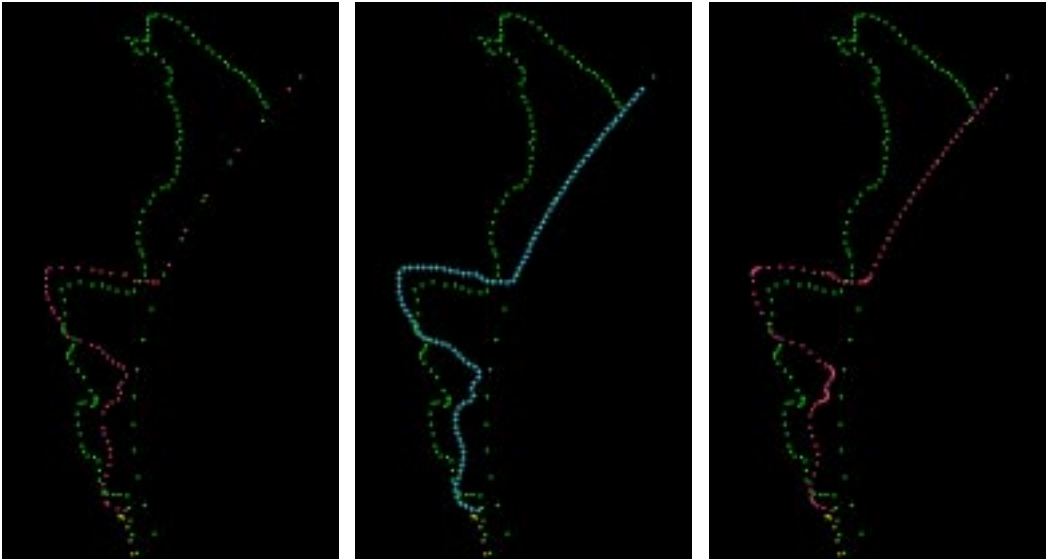


Figure 27. Left to right: original distribution; uniformly discretized to 100 points; discretized by curvature.

Change subcurve using free form method

This allows you to smooth the subcurve and modify the subcurve by moving control points that define its shape.

- Make sure the view is zoomed into the area at the front of the airfoil (Figure 28).
- Switch to object 3 and select indices 1 and 112 as the endpoints of the subcurve. (Remember to exit Choose Subcurve mode when you are done.)
- From the main menu, select:
Boundary->Change Free Form Subcurve...
- The **check boxes** in this window will allow you to display the current points, the smoothed (modified) points, and the control points, as well as the lines connecting those points. Try turning these on and off.
- Increase the number of **Smoothed** points to 150 by typing that value in the text box and pressing <Enter>.

- Decrease the number of **Control** points to 40 by typing that value in the text box and pressing <Enter>. This has the effect of smoothing the subcurve.
- You may also modify the curve by moving the control points. Press the **[Move FF Control Pts]** button. You are now in the Move FF Control Points mode. Follow the instructions to move control points. To exit this mode, press the right mouse button.
- Make changes permanent, or discard the changes the same way you did in the *Tanh Redistribution* window.

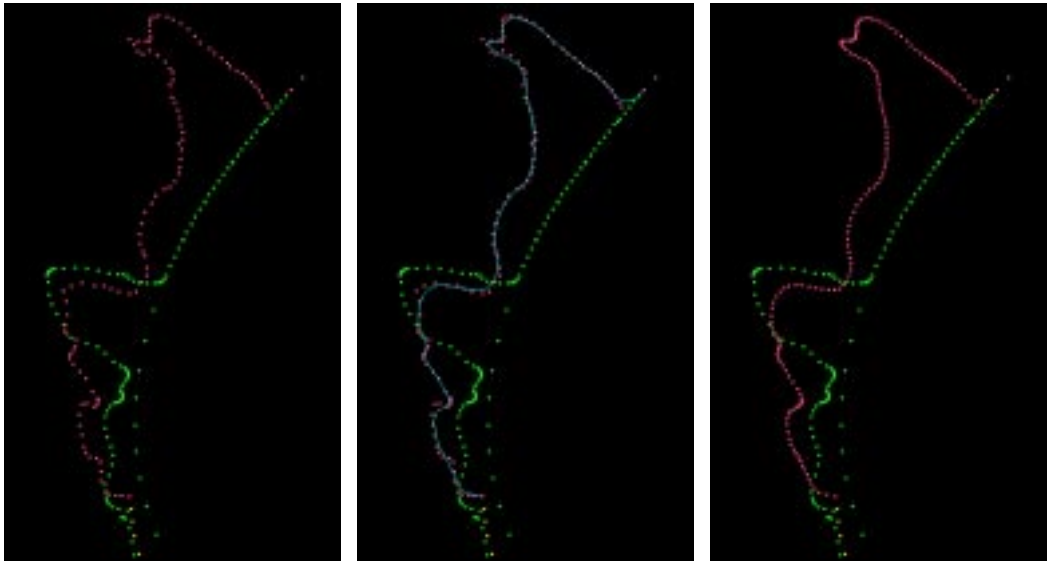


Figure 28. Left to right: original points; curve smoothed using 40 control points (control points not shown); new curve with 150 points.

Save modified geometry

After making these changes to the geometry, you may want to save the geometry to a new file.

- From the main menu, select: *File->Save As...*
- Under the **Save Object** option menu, select *All Elements*. Type the name of the new file in the **Selection** text box and click **[Save]**.
- You may want select *Edit->Clear All* and then read in this new file to verify that the changes were saved.

Scenario 3 - Measuring Ice Shapes

This section will step you through the process of making measurements of ice shapes, i.e., probing.

Startup

- Start SmagglIce (or select *Edit->Clear All*, if already running a session).
- Read the element file: `clean+3ice.scaled.elc`. This file contains 4 closed elements: a clean airfoil and three iced airfoils.
- Zoom in to the area at the leading edge of the airfoil.
- Select object 2 to be the current object.

Display point coordinates

You can display the coordinates of points in the current object. When you select a point, both its index and its (x,y) coordinates are displayed in the **Information** area of the main screen.

- From the main menu, select: *View->Display Point Coordinates*
- Follow the instructions in the lower left corner of the screen to select points and display their coordinates in the **Information** area. These coordinates are for immediate reference only. The following steps will show you how to keep a record of point locations, as well as other types of probing information.
- To exit Display Point Coordinates mode, press the right mouse button.

Select reference airfoil

For some measurements, such as $(X - X_{le}) / C$, a clean airfoil must be identified as a reference, since the chord length C is determined from the clean airfoil. The chord length can also be used to normalize measurements such as length. In order to choose these calculations, you must first identify the clean airfoil so that the chord length can be determined.

- Select object 1 (the clean airfoil).
- From the main menu, select: *Element->Set Reference Airfoil*.
- You may want to highlight the clean airfoil by selecting from the main menu: *View->Highlight Reference Airfoil*. Notice that there are two additional points marked with purple crosses: the leading edge point, and the center of the leading edge circle. During probing, you may select these points as you would others. (Figure 29)

Make measurements

- From the main menu, select: *Element->Ice Shape Characteristics*.
- Comments may be entered at any time into the Probe Information Table. Type "Probing Tutorial" in the comment text area, and press the <Enter> key or the [Enter Comment] button.

Location

Make a location measurement:

- Select *Location (X,Y)* from the **Probe Measurement** option menu. Follow the instructions in the **Instruction** area of the main window to select a point. Now select a different point. Notice how the probe information is displayed in the **Information** area of the main window. However, nothing is entered into the Probe Table until you press the right mouse button. Now enter the location into the Probe Table by pressing the right mouse button.

Length

You will next make a measurement of normalized length:

- Change the **Probe Measurement** to *Length*.
- You are currently able to choose points from all objects. Now change the **Point Selection Method** by selecting *Current Object* from that option menu. This will limit the points which may be selected to those on the current object only.
- Click on the **Normalize** check box to measure normalized length. This will normalize all measurements by dividing them by the chord length, which in this case is 8.000225.
- Type the string "LE circ rad" into the **Label** text field, indicating that this will be a measurement of the radius of the circle inscribed in the leading edge of the airfoil. This label will be entered into the Probe Table when you enter the measurement.
- Follow the instructions to select two endpoints: one being the leading edge of the airfoil, the other being the center of the leading edge circle (both marked in purple crosses). Enter the measurement into the Probe Table. Note that if the reference airfoil is not highlighted, you will not be able to select these two points.

Glyphs

You will have noticed that after measurements are entered into the Probe Table, symbols (or glyphs) such as points and lines are overlaid on the geometry to indicate where the measurements were made. You may want to turn off the display of these glyphs by selecting from the main menu: *View->Display Glyphs*.

Arc length

Arc length measures the sum of the lengths of the line segments along a boundary between two points on that boundary.

- Set the **Probe Measurement** to *Arc Length*, and turn **Normalize** off.
- Select the two endpoints: one being the leading edge of the reference airfoil, the other being the location where the ice attaches to the airfoil at the upper surface.
- Change the **Label** to “ice limit”, and enter the measurement into the Probe Table.

Angle

To measure an angle, you will need to mark two lines between which the angle will be measured. Normalizing this measurement has no effect.

- Set the **Probe Measurement** to *Angle*.
- Following the instructions in the **Instruction** area, set the endpoints of the first line: the center of the leading edge circle and the leading edge point itself.
- For the second line, set the first endpoint to again be the center of the leading edge circle. For the second endpoint, set the **Point Selection Method** to *All Objects*, and select the tip of the uppermost ice horn.
- Change the **Label** to “upper horn”, and enter the measurement into the Probe Table.

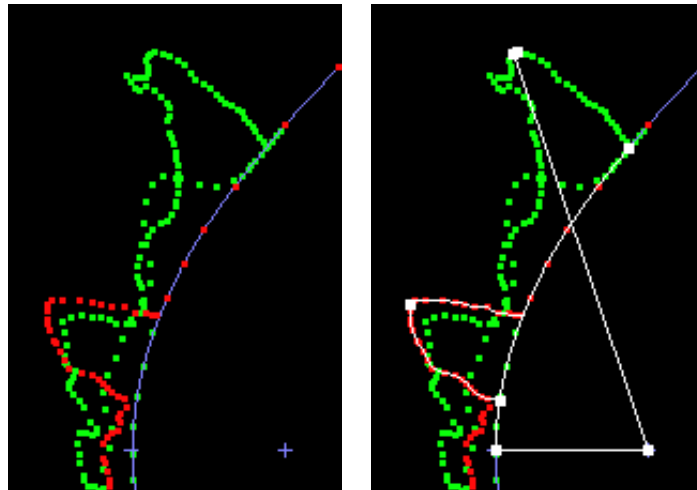


Figure 29. Left: highlighted reference airfoil with markers at leading edge and center of leading edge circle; Right: glyphs marking measurements of location, length, arc length, angle, and $(X-X_{le})/C$.

(X-X_{le})/C

This measurement calculates the value $(X-X_{le})/C$, where X is the x-location of the point selected, X_{le} is the x-location of the leading edge, and C is the chord length of the reference airfoil.

- Set the **Probe Measurement** to $(X-X_{le})/C$.
- Set the **Label** to “ice tip”, select the point on the tip of the uppermost ice horn, and enter the measurement into the Probe Table
- **Ice Area** - (example information).

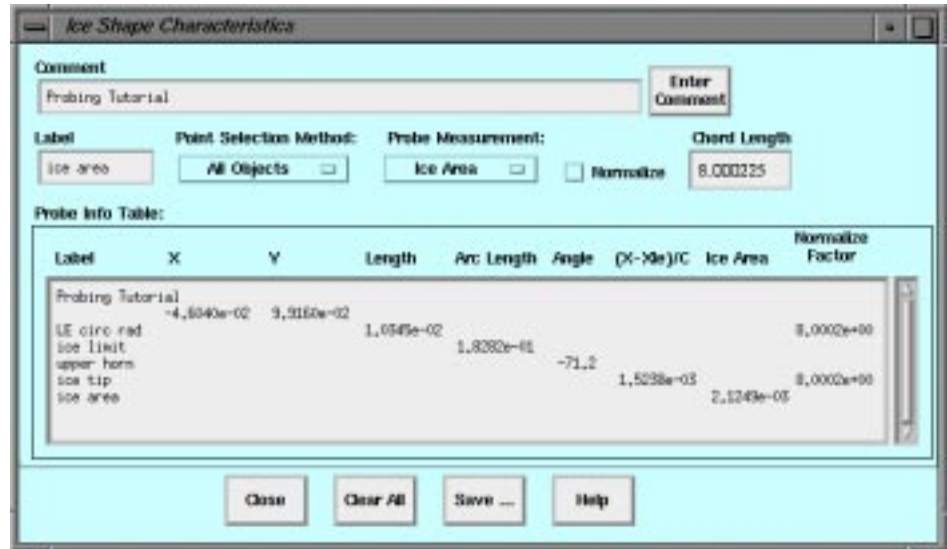


Figure 30. Ice Shape Characteristics window with entries in the Probe Table.

Save probe information

At this point, you may want to save the probe information to a file.

- In the *Ice Shape Characteristics* window, press the **[Save.]** button. This will bring up a subwindow which will allow you to save the Probe Table to a text file.
- You may also save a screen image of the geometry with the lines and points of your measurements displayed. First turn glyph display back on by selecting *View->Display Glyphs* from the main menu, then select *File->Screen Save....* You may choose to save the image as a TIFF, GIF, or PPM image file.
- To clear the Probe Table and all associated glyphs, press the **[Clear All]** button in the *Ice Shape Characteristics* window.

Scenario 4 - Add Artificial Ice Shape

This section will show you how to add artificial ice shapes to an airfoil.

Startup

- Start SmagglIce (or select *Edit->Clear All*, if already running a session).
- Read the element file: `clean.elc` from the directory `$HOME/smaggice1.2/geometry`.
- Artificial ice is added to the reference airfoil, so set that first. From the main menu select: *Element -> Set Reference Airfoil*.

Add Spoiler

- From the main menu, select: *Element -> Add Artificial Ice*.
- Select Rectangle push button. At this point you will see a small rectangle on the upper surface of the airfoil near the leading edge.
- Type an X-location of `.02` and press <Enter>.
- Type a length of `.08`, and angle of `10`, and `8` as the number of points in the Y-direction. Notice that as you type parameters in the text area, no changes are displayed until you press <Enter>. Now press <Enter>. You will see a preview of the points on the spoiler displayed as blue crosses.
- To make these changes permanent, press the “Apply” push button.



Figure 31. Airfoil with spoiler.

Add Train of Shapes

- Select the Semi-circle push button.
- Select the lower surface
- Enter the following values:
X-location: `.1`
Shapes: `10`
Distance Between: `.01`
Radius: `.02`
Press <Enter> to see a preview.

- Click the “Okay” push button to make changes permanent and close this window.

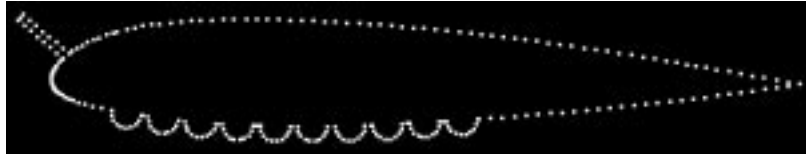


Figure 32. Airfoil with spoiler and train of ice shapes.

Scenario 5 - Move Element

This section will show you how to translate the current element and rotate it about a hinge point.

Startup

- Start SmagIce (or select *Edit->Clear All*, if already running a session).
- Read the element file: `3elem.all.elc` from the directory `$HOME/smaggice1.2/geometry`.
- Notice that there are three closed objects: the slat, the main airfoil and the flap. Make sure that object 1 is selected, which is the slat.

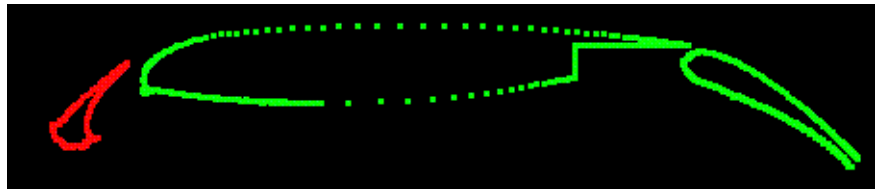


Figure 33. Geometry file: `3elem.all.geo`; object 1 selected.

Move Element

- From the main menu, select: *Element -> Move Element*.
- Change the **Rotation** parameter: drag the slider to the left to -20 or enter the value in the adjacent text field and press <Enter>. Notice the slat is rotated around the hinge point location [0,0]. Translate the object by entering a value of .05 for X-translation and .05 for Y-translation. Press <Enter>.

- The Graphics Window displays the original current element (red dots) and a preview of the translated/rotated object (blue crosses).

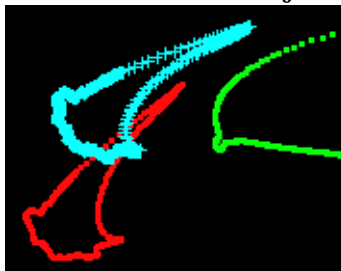


Figure 34. Rotation and translation of the slat

- Press the “Apply” pushbutton to make the changes permanent. The window will stay open to allow you to make further changes. When you are finished press the “Close” push button. If you want to make changes permanent and close the window in one step, press the “Apply” button.

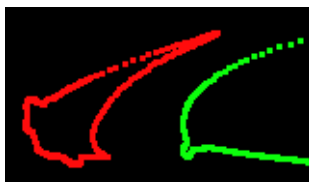


Figure 35. Permanent changes of the slat